

Chemistry I: Midterm Review 2013

General Stuff

1. Density and formula: density is mass per unit volume

$$D = \frac{m}{V}$$

The units usually are g/cm³ or g/L or g/mL

2. Define Accuracy and precision: Accuracy refers to the correctness of a single measurement. Accuracy is determined by comparing the measurement against the true or accepted value. Precision refers to how well experimental data and values agree with each other in multiple tests.
3. Metric system is the system of measurement based on units of ten; should know mm, cm, m and km. Also mL and L

Matter and its changes

4. Describe the basic properties of matter in terms of mass and volume. Mass is how much matter something contains. Volume is how much space a given amount of matter occupies.
5. State the Law of Conservation of Matter and Energy: matter and energy cannot be created or destroyed only changed into different forms.
6. Define elements, compounds, and mixtures (provide 3 examples of each)

	definition	3 examples
element	Any substance that cannot be broken down by ordinary chemical means	Lead Gold chlorine
Mixture	Any substance that can be broken down by physical means such as distillation	Mud Jello w/ fruit concrete
compound	Any substance that can be broken down by ordinary chemical means	Water Calcium chloride Diphosphorus pentoxide

2013 Midterm Exam Review

6. List the physical and chemical properties metals, nonmetals and metalloids.

	Physical properties	Chemical properties
metals	Can conduct heat Can conduct electricity Can bend Can stretch Have luster	React with acids React with nonmetals to make ionic cmpds
nonmetals	Cannot conduct heat Cannot conduct electricity brittle Have no luster	
metalloids	will exhibit properties of both metals and nonmetals.	

7. Where are metals, nonmetals, and metalloids on periodic table? Metals can be found on the left side of the table and below the stair step. Metalloids can be found on the stair step starting at B and ending with At. Nonmetals are found in the upper right corner of the table to the right of the stair step.

8. Provide 5 examples of chemical change

Light is released, heat is released, a gas (vapor) is released, a change in color, and a precipitate is formed and comes out of solution.

9. 4 things to start a chemical reaction

Heat is applied to the reactants; substances are exposed to light, stirring, a catalyst is used.

10. Define physical and chemical changes and list 3 examples of each

Physical changes are those changes that occur to a substance that does not change the elemental makeup of that compound. E.g. ice melting, gasoline evaporating, dew forming.

Chemical changes are those changes that result in new substances with new physical properties being made. E.g. wood burning, sour mash fermenting, eggs frying

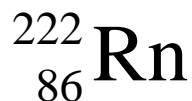
11. Define a Precipitate: is a very slightly soluble or insoluble compound that is produced in a chemical reaction. Usually collects on the bottom of the container (test tube).

Mid Year Problems: Show all WORK

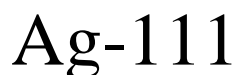
Chapter 3: Atomic structure

12. Define the following terms:

- a) An atom is the defining structure of an element, which cannot be broken by any chemical means. A typical atom consists of a nucleus of protons and neutrons with electrons orbiting this nucleus.
- b) Isotopes are atoms of the same element with differing number of neutrons
- c) The 3 basic atomic particles are proton, neutron and electron.
- d) Atomic number is the number of protons in the nucleus of an atom.
- e) Atomic mass is the sum of the number of neutrons and the number of protons
- f) Explain the following isotopic symbol and abbreviated version.



This is a complete isotopic which shows the atomic number and mass number along with the element symbol.



This is an abbreviated isotopic symbol which is comprised of the element symbol and the mass number of a particular isotope

13. Explain the significance of Ernest Rutherford's gold foil experiment.

The gold foil experiment showed that atoms are mostly empty space. The center of the atom has a dense positively charged nucleus. This is referred to as a "nuclear" atom.

14. Define the quantum model of the atom.

This model of the atom has a dense positively charged nucleus that contains 99 % of the mass comprised of neutrons and a number of protons (specific to each element). Located outside of the nucleus is the electron cloud. Within the e^- cloud, electrons may be found in 3-D regions of space called orbitals. These orbitals have characteristic shapes which are described by wave mechanics and probability.

Arrangement of Electron in Atoms

15. Define the following terms:

- a) Bright line spectrum is the spectra produced by electrons in atoms that are returning to the ground state from the excited state. When this occurs photons of specific frequency are produced and appear as bright lines.
- b) One quantum of energy is a package of energy described by Planck's equation $E = hf$

2013 Midterm Exam Review

- c) One photon of light energy is a quanta of energy in the visible spectrum
 - d) Valence electrons are the electrons in the outermost energy level and are involved in the chemical bonding process.
16. Electron configuration is the distribution of electrons of an atom (or other physical structure) in atomic orbitals. For example, the electron configuration of the Ne atom is $1s^2 2s^2 2p^6$.
17. Orbital notation is a way to diagram electrons in their specific orbitals to see how atoms might bond.

The Periodic Law

18. Periodic Law states that the physical and chemical properties of the elements are functions of their atomic numbers.
19. Define the following terms:
- a) Ionization energy is the energy needed to remove the most loosely held electron from an atom. Metals typically have low ionization energy. Nonmetals typically have high ionization energy.
 - b) Atomic radius of an element is a measure of the size of its atoms, usually the mean or typical distance from the nucleus to the boundary of the electron cloud.
 - c) Electronegativity is a measure of the attraction of an atom for electrons in a covalent bond.

Mid Year Problems: Show all WORK

20. Describe the trends of the following periodic properties as you go down a family / group on the Periodic Table

	Trend top to bottom	Trend left to right
Ionization energy	Decreases because outermost electrons are shielded by the innermost electrons from the nucleus	Increases with greater nuclear charge
Atomic radius	Increases as more energy levels are added. (aufbau rule)	Decreases with greater nuclear charge pulling the electron cloud closer to nucleus.
Electronegativity	Electronegativities generally decrease from top to bottom down a group. Francium has the lowest electronegativity.	Electronegativities generally increase from left to right across a period with the Group VII element having the highest value for the period.
Reactivity	Metals increase Nonmetals decrease	Decreases as you get closer to noble configuration.

2013 Midterm Exam Review

Chemical bonds

21. Define the following terms:

- a) **Coordinate covalent bond** (also called a dative bond) is formed when one atom donates both of the electrons to form a single covalent bond. These electrons originate from the donor atom as an unshared pair.
- b) **Double/ triple covalent bonding** occurs when the 2 atoms involved share 2 pair (4 e⁻) or 3 pair of electrons the complete the octet.
- c) **Polyatomic ions (radicals)** are covalently bonded species that have a charge thus making them ions, usually negative. There are 2 common polyatomic cations
- d) **Ionic bonding** transfer of electrons between atoms that create ions of opposite charge that will attract to form a crystal (or lattice)
- e) Define cation and anion
 - 1. Anion is a negatively charged ion
 - 2. Cation is a positively charged ion

22. Be able to determine polarity of covalent molecules (molecular polarity)

23. Determine polar and non-polar bond using electronegativity values.

Chemical Composition:

24. Define the following terms:

- a) **Law of definite composition** states that the elements in a given compound are always combined in the same proportion by mass. This law forms the basis for the definition of a chemical compound.
- b) **Law of multiple proportions** states that when two elements combine with each other to form more than one compound, the weights of one element that combine with a fixed weight of the other are in a ratio of small whole numbers. Example: CO and CO₂
- c) **Molar masses of chemical compounds** are equal to the sums of the atomic masses of all the atoms in the formula. The molar mass of any molecular compound is the mass in grams numerically equivalent to the sum of the atomic masses of the atoms in the molecular formula. If the formula used in calculating molar mass is the molecular formula, the formula weight computed is the molecular weight.

a) Families	b) Periods	c) Alkali metals	d) Alkaline earth metals
e) Transition metals	f) Halogens	g) Noble gasses	h) Lanthanides
i) Actinides	j) "s" block	k) "p" block	l) "d" block

1. For each capital letter above: Write the **e-config** , **Lewis dot symbols** and **oxidization #'s**

Chemistry I: Midterm review

2013 Midterm Exam Review

F	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2$	$\begin{array}{c} \cdot \\ \text{Ba} \cdot \end{array}$	+2
G	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$	$\begin{array}{c} \cdot \cdot \\ : \text{Rn} : \\ \cdot \cdot \end{array}$	0
H	$1s^2 2s^2 2p^6 3s^1$	$\begin{array}{c} \cdot \\ \text{Na} \end{array}$	+1
I	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$	$\begin{array}{c} \cdot \\ \text{Fe} \cdot \end{array}$	+2
J	$1s^1$	$\text{H} \cdot$	+1

3. Draw the following molecules and determine their shape

Molecule	Lewis structure	Geometry
$\text{CH}_3\text{CH}_2\text{OH}$	$ \begin{array}{ccccccc} & & \text{H} & & \text{H} & & \\ & & & & & & \cdot \cdot \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{O} : \\ & & & & & & \\ & & \text{H} & & \text{H} & & \text{H} \end{array} $	linear
SCl_2	$ \begin{array}{ccccc} & & \cdot \cdot & & \\ & & : & & : \\ \text{Cl} & : & \text{S} & : & \\ & & \cdot \cdot & & \\ & & \text{Cl} & & \end{array} $	bent
$\text{CH}_3\text{CH}_2\text{COOH}$	$ \begin{array}{ccccccc} & & \text{H} & & \text{H} & & : \text{O} : \\ & & & & & & \cdot \cdot \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{C} - \text{O} : \\ & & & & & & \\ & & \text{H} & & \text{H} & & \text{H} \end{array} $????

Mid Year Problems: Show all WORK

Draw examples of the following ionic bonds

Ionic Compound	Lewis drawing
LiBr	$\text{Li} \cdot \longrightarrow [\text{Li}]^{+1} \quad \cdot \ddot{\text{Br}} \cdot \longrightarrow \left[\begin{array}{c} \cdot \ddot{\text{Br}} \cdot \\ \cdot \ddot{\text{Br}} \cdot \end{array} \right]^{-1}$ $\left[\text{Li} \right]^{+1} \quad \left[\begin{array}{c} \cdot \ddot{\text{Br}} \cdot \\ \cdot \ddot{\text{Br}} \cdot \end{array} \right]^{-1}$
BaCl ₂	$\cdot \text{Ba} \cdot \longrightarrow [\text{Ba}]^{+2} \quad \cdot \ddot{\text{Cl}} \cdot \longrightarrow \left[\begin{array}{c} \cdot \ddot{\text{Cl}} \cdot \\ \cdot \ddot{\text{Cl}} \cdot \end{array} \right]^{-1}$ $\left[\text{Ba} \right]^{+2} \quad 2 \left[\begin{array}{c} \cdot \ddot{\text{Cl}} \cdot \\ \cdot \ddot{\text{Cl}} \cdot \end{array} \right]^{-1}$
Mg ₃ N ₂	$\cdot \text{Mg} \cdot \longrightarrow [\text{Mg}]^{+2} \quad \cdot \ddot{\text{N}} \cdot \longrightarrow \left[\begin{array}{c} \cdot \ddot{\text{N}} \cdot \\ \cdot \ddot{\text{N}} \cdot \end{array} \right]^{-3}$ $3 \left[\text{Mg} \right]^{+2} \quad 2 \left[\begin{array}{c} \cdot \ddot{\text{N}} \cdot \\ \cdot \ddot{\text{N}} \cdot \end{array} \right]^{-3}$

Write correct formulas for the following compounds:

Potassium oxide K ₂ O	Carbon tetraiodide CI ₄	Diphosphorus pentoxide P ₂ O ₅
Aluminum sulfide Al ₂ S ₃	Dinitrogen oxide N ₂ O	Silver sulfide Ag ₂ S
Copper (II) nitrate Cu(NO ₃) ₂	Ammonium phosphate (NH ₄) ₃ PO ₄	Ferrous sulfate FeSO ₄
Lead (IV) oxide PbO ₂	Cupric hydroxide Cu(OH) ₂	Stannous bicarbonate Sn(HCO ₃) ₂

2013 Midterm Exam Review

2. **Correctly name** the following compounds:

$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$ Ammonium acetate	Cr_2O_3 Chromium (III) oxide	$\text{Pb}(\text{NO}_3)_2$ Lead (II) nitrate OR Plumbous nitrate
Ag_2CrO_4 Silver chromate	P_4O_{10} Tetraphosphorus decoxide	NBr_3 Nitrogen tribromide
$\text{Al}_2(\text{CrO}_4)_3$ Aluminum chromate	$\text{Sn}(\text{Cr}_2\text{O}_7)_2$ Tin (II) dichromate OR Stannous dichromate	N_2O_4 Dinitrogen tetroxide

3. For the following calcium compounds: **write the formulas** and **find the % of calcium** in each

Calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$ molar mass= 310 g/mol

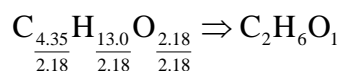
$$\% \text{Ca} = \frac{120\text{g}}{310\text{g}} \times 100\% = 38.7\%$$

Calcium nitrate $\text{Ca}(\text{NO}_3)_2$ molar mass= 164 g/mol

$$\% \text{Ca} = \frac{40\text{g}}{164\text{g}} \times 100\% = 24.4\%$$

Calculate the empirical formulas for the following

52.2% **C** 13.00% **H** 34.80% **O**

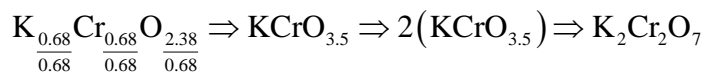


$$\text{C} = \frac{52.2\text{g}}{12.0\text{g}} = 4.35 \text{ mol}$$

$$\text{H} = \frac{13.00\text{g}}{1.0\text{g}} = 13.0 \text{ mol}$$

$$\text{O} = \frac{34.80\text{g}}{16.0\text{g}} = 2.18 \text{ mol}$$

26.56 % **K** 35.41 % **Cr** 38.03 % **O**



$$\text{K} = \frac{26.56\text{g}}{39.1\text{g}} = 0.68 \text{ mol}$$

$$\text{Cr} = \frac{35.41\text{g}}{51.9\text{g}} = 0.68 \text{ mol}$$

$$\text{O} = \frac{38.03\text{g}}{15.9\text{g}} = 2.38 \text{ mol}$$

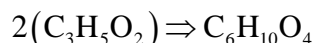
Mid Year Problems: Show all WORK

4. **Calculate the molecular formula** for a compound that is 49.3% C 6.9% H and 43.8% O with a molar mass of 146 g/mol

$$C = \frac{49.3g}{12.0g} = 4.10 \text{ mol} \quad H = \frac{6.9g}{1.0g} = 6.9 \text{ mol} \quad O = \frac{43.8g}{15.9g} = 2.75 \text{ mol}$$

$$C_{\frac{4.10}{2.75}} H_{\frac{6.9}{2.75}} O_{\frac{2.75}{2.75}} \Rightarrow C_{1.5} H_{2.5} O_1 \Rightarrow 2(C_{1.5} H_{2.5} O_1) \Rightarrow C_3 H_5 O_2 \text{ Then compare the empirical FW}$$

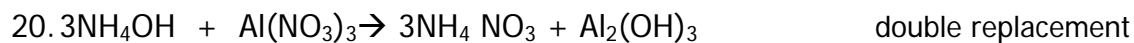
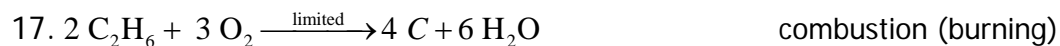
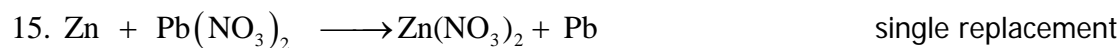
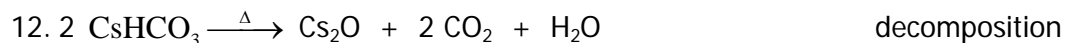
with the molecular weight: $\frac{146g}{73g} = 2$ So the correct molecular formula



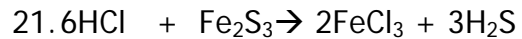
5. **Complete and balance the following chemical reactions:**

6. **Identify the following reactions by type.**

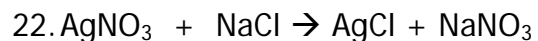
7.



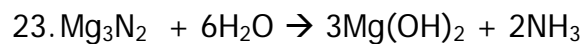
2013 Midterm Exam Review



double replacement



double replacement



double replacement

26. Explain each of the following formulas. Define the variables and state the mathematical relationship

$$E = hf$$

$$c = \lambda f$$

$$E = mc^2$$